

(19)



(11)

EP 2 522 971 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:
26.10.2016 Bulletin 2016/43

(51) Int Cl.:
G01K 13/02 (2006.01)

(21) Application number: **12167225.7**

(22) Date of filing: **09.05.2012**

(54) Method and assembly for high angle of attack process parameter sensors

Verfahren und Baugruppe für einen hohen Winkel von Angriffsprozessparametersensoren

Procédé et ensemble d'angle d'attaque élevée des détecteurs de paramètres de processus

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**

(30) Priority: **11.05.2011 US 201113105635**

(43) Date of publication of application:
14.11.2012 Bulletin 2012/46

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US-B1- 7 845 222**

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Description

BACKGROUND OF THE INVENTION

[0001] The field of the invention relates generally to process parameter sensing devices and more specifically, to an assembly and method of sensing a process parameter.

[0002] At least some known total air temperature (TAT) sensors are limited in their ability to maintain accurate measuring capability at high angles of attack. An airfoil channeling airflow towards a sensing element of the sensor can cause a flow separation on the airfoil if the angle of attack is increased beyond a certain angle for example, +/- 15 degrees. The separation can result in an extreme recovery error and convective film variation.

[0003] US 2006/0056489 A1 relates to a sensor for measuring total air temperature.

[0004] WO 94/25842 A1 relates to a temperature sensor having an integral debris guard.

[0005] US 7,845,222 B1 relates to a method and assembly for sensing process parameters.

BRIEF DESCRIPTION OF THE INVENTION

[0006] In one aspect, a sensing assembly is provided in accordance with claim 1 herein.

[0007] In another aspect, a method of sensing a process parameter is provided in accordance with claim 7 herein.

[0008] In yet another embodiment, a process sensing system includes a first extension member and a second extension member extending parallelly from a base and spaced apart by a flow channel and a sensor assembly extending between the first and second extension members. The sensor assembly includes a center airfoil body and a sensor element positioned downstream of the center airfoil body, a first airfoil body spaced apart from the center airfoil body by a first flow channel, the first airfoil body including a concave surface facing the center airfoil body, and a second airfoil body spaced apart from the center airfoil body by a second flow channel, the second airfoil body including a convex surface facing the center airfoil body.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

Figures 1-4 show exemplary embodiments of the method and assembly described herein.

Figure 1 is a perspective view of a sensing assembly in accordance with an exemplary embodiment of the present invention;

FIG. 2 is a plan view of the extension member shown in FIG. 1 taken along lines 2-2 also shown in FIG. 1;

FIG. 3 is a side elevation view of sensor assembly shown in FIG. 1 taken along lines 3-3 also shown in FIG. 1; and

FIG. 4 is a flow diagram of a method of sensing a process parameter.

DETAILED DESCRIPTION OF THE INVENTION

[0010] The following detailed description illustrates embodiments of the invention by way of example and not by way of limitation. It is contemplated that the invention has general application to analytical and methodical embodiments of sensing process parameters in industrial, commercial, and residential applications.

[0011] As used herein, an element or step recited in the singular and proceeded with the word "a" or "an" should be understood as not excluding plural elements or steps, unless such exclusion is explicitly recited. Furthermore, references to "one embodiment" of the present invention are not intended to be interpreted as excluding the existence of additional embodiments that also incorporate the recited features.

[0012] Embodiments of the present invention describe a gas turbine engine fan inlet temperature sensor capable of operating accurately over an angle of attack range of $\pm 30^\circ$. The fan inlet temperature sensor described herein uses a symmetrical airfoil for the extension member that extends from a wall of the fan inlet, however embodiments of the invention are not to be limited to only symmetrical airfoils. Flow separation on the extension member airfoil at large angles of attack can result in an extreme recovery error, time response, and convective film variation. Managing the flow separation is critical in consistent sensor performance especially at higher mach numbers. Embodiments of the present invention straighten the airflow that reaches the sensing element using a "V" channel with rounded tip profiles.

[0013] The "V" channel forces air to directly impinge on the sensing element, because the airfoil is symmetrical, the air flow stays attached to the wall of the "V" channel until the angle of attack reaches approximately $\pm 50^\circ$. The flow path generates an area of high pressure as well as an area of low pressure. This pressure differential forces the air flow to change direction. This direction change ensures the massive water particles and dust particles can not directly impact the sensing element. The mass of the water and dust is so large that momentum of these particles makes it impossible to make the same sharp turn that the air flow is able to make. After the air flow has been turned, and the water and dust have been separated out of the air flow, the air flow is channeled into an outer sheath over the sensing element. The outer sheath decreases the air velocity around the sensing element, this reduction in air velocity raises the temperature of the air to almost that of the true total temperature. The difference between the sensed temperature and that of the true total temperature of the air is then used to

calculate the recovery error of the sensor. The outer sheath also promotes a large uniform convective film on the outside of the sensing element. This large uniform convective film decreases the transient response of the sensing element as well as reduces excitation error and conduction error. The pressure differential that drives airflow to the sensing element is generated using three relatively smaller airfoils.

[0014] The fan inlet temperature sensing element is a resistance temperature detector (RTD) that measures the engine inlet total air temperature. It is a hermetically sealed, dual element, electrical device that exhibits a change in resistance proportional to air temperature changes. Signals from both elements are routed to the Full Authority Digital Engine Control (FADEC). A single electrical connector provides the electrical interface. The sensor assembly uses electric heaters powered by the electric anti-ice system to prevent the formation of ice on the sensor assembly housing under service conditions. In various embodiments, the sensor assembly is constructed from hardened Inconel 718, which is sufficiently hard so as not to be damaged when exposed to sand and dust particle impingement. The area most susceptible to sand and dust impingement, the sensing element, is protected by a center airfoil body of the sensor assembly. All water and sand particles are separated out by the airfoil design.

[0015] Figure 1 is a perspective view of a sensing assembly 100 in accordance with an exemplary embodiment of the present invention. In the exemplary embodiment, sensing assembly 100 includes a base 102 and a sensor assembly 104. Sensor assembly 104 includes a sensing element 106 (not visible in FIG. 1), a first flow channel 108 and a second flow channel 110. Sensor assembly 104 also includes an extension member 112 extending between base 102 and sensor assembly 104. Base 102 includes a flange 114 and a boss 116. Flange 114 is configured to couple sensing assembly 100 to a wall of a process conduit, for example, an inlet duct of a gas turbine engine. Boss 116 is configured to receive electrical wiring within to permit coupling electrical components within sensing assembly 100 to power sources and/or control devices (not shown). A connector housing 118 is configured to matingly engage boss 116. Connector housing 118 includes a connector 120 through which wires pass from connector housing 118 to a cable (not shown).

[0016] FIG. 2 is a plan view of extension member 112 (shown in FIG. 1) taken along lines 2-2 (also shown in FIG. 1). In the exemplary embodiment, extension member 112 includes a first leg 202 and a second leg 204 that defines a flow channel 206 therebetween. Flow channel 206 includes a converging V-channel segment 208 upstream with respect to a straightening segment 210. A flow of fluid 212 enters converging V-channel segment 208 and is accelerated into straightening segment 210.

[0017] FIG. 3 is a side elevation view of sensor assembly 104 (shown in FIG. 1) taken along lines 3-3 (also

shown in FIG. 1). In the exemplary embodiment, sensor assembly 104 includes a first airfoil body 302, a second airfoil body 304, and a center airfoil body 306. Also in the exemplary embodiment, first airfoil body 302, second airfoil body 304, and center airfoil body 306 extend orthogonally with respect to extension member 112. In one embodiment, extension member 112 is oriented vertically when properly installed for use and therefore first airfoil body 302, second airfoil body 304, and center airfoil body 306 are oriented substantially horizontally when properly installed for use. During operation however, in certain applications sensing assembly 100 may be operated at pitch angles that change the orientation of extension member 112, first airfoil body 302, second airfoil body 304, and center airfoil body 306 with respect to the vertical and horizontal orientations. In addition, certain operating conditions cause airflow to enter sensor assembly 104 at various angles, including up to approximately 50° incline and decline (pitch) and/or a rotation about sensor assembly 104 (yaw).

[0018] Sensor assembly 104 further includes sensing element 106 and a sheath 308 that at least partially surrounds sensing element 106. In the exemplary embodiment, sensing element 106 has a substantially cylindrical body and sheath 308 is also substantially cylindrical. An outer surface 310 of sensing element 106 and an inner surface 312 of sheath 308 define a gap 314 between them. A first upstream opening 316 in sheath 308 permits fluid entry into gap 314 and a second downstream opening 318 in sheath 308 permits fluid egress from gap 314.

[0019] First airfoil body 302 includes a substantially J-shaped cross-section with a longer leg 320 of the "J" aligned into the direction of fluid flow and a shorter leg 322 oriented towards second airfoil body 304. First airfoil body 302 includes a concave surface facing center airfoil body 306. Second airfoil body 304 includes a triangular cross-section with an apex 324 of the triangle proximate sensing element 106 and sheath 308. Second airfoil body 304 includes a convex surface facing center airfoil body 306. Center airfoil body 306 includes a substantially isosceles triangle shape with an apex 326 of center airfoil body 304 aligned into the direction of fluid flow.

[0020] First airfoil body 302 and center airfoil body 306 define first flow channel 108 to include a converging segment 328, a straightening segment 330, and a turning segment 332. Turning segment 332 includes a turn radius 334 configured to separate particles from a flow 336 entering turning segment 332. As flow 336 enters turning segment 332 and begins to turn, particles, moisture droplets, and ice, because of their momentum, will not be able to turn as rapidly as the fluid itself. Accordingly, flow 336 will separate into a particle-laden stream 338 and a particle-reduced stream 340. Particle-laden stream 338 will pass between sheath 308 and first airfoil body 302 and not be introduced into gap 314 or impinge sensing element 106. Particle-reduced stream 340 will be able to turn sufficiently to be directed into upstream opening 316 to be measured by sensing element 106. Flow 336 is

facilitated being introduced into opening 316 by an area 342 of relatively high pressure generated in turning segment 332 by a shape of flow channel 108. Area 342 is generated upstream from sensing element 106 in turning segment 332.

[0021] Second airfoil body 304 and center airfoil body 306 define second flow channel 110 therebetween. Second flow channel 110 is configured to generate a low pressure area 344 downstream of sensing element 106.

[0022] FIG. 4 is a flow diagram of a method 400 of sensing a process parameter. In the exemplary embodiment, method 400 includes channeling 402 a flow of fluid through a first flow passage defined between a first airfoil body and a center airfoil body, channeling 404 the flow of fluid through a second flow passage defined between a second airfoil body and the center airfoil body, turning 406 the flow of fluid in the first flow passage to facilitate separating the flow of fluid in the first flow passage into a first stream having relatively reduced particulates with respect to a second stream, and directing 408 the first stream to a sensor element. Method 400 optionally includes generating an area of relatively high pressure in the first flow passage and/or generating an area of relatively low pressure in the second flow passage. In various embodiments, method 400 includes reducing a velocity of the flow of fluid exiting the first flow passage proximate the sensor element. In yet other embodiments, the velocity of the flow of fluid exiting the first flow passage is reduced proximate the sensor element using a sheath surrounding the sensor element. Method 400 may also include directing the flow of fluid exiting the first flow passage into an opening in a sheath surrounding the sensor element.

[0023] The above-described embodiments of a method and assembly for sensing a process parameter provides a cost-effective and reliable means for reducing effects of direct water and/or ice impingement on the sensor, angle of attack, and time response. More specifically, the methods and assembly described herein facilitate separating water and/or ice from a flow of fluid. In addition, the above-described methods and assembly facilitate sampling a low velocity portion of the flow of fluid without moving parts in the process sensor assembly. As a result, the methods and assembly described herein facilitate measuring parameters of a process in a cost-effective and reliable manner.

[0024] This written description uses examples to disclose the invention, including the best mode, and also to enable any person skilled in the art to practice the invention, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the invention is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they have structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal languages of the

claims.

Claims

1. A sensing assembly (100) comprising:

a base (102);
a sensor assembly (104), said sensor assembly comprising:

a sensor (106);
a first flow channel (108) defined by a first airfoil (302) and a center airfoil (306); the first flow channel comprising a converging segment (328), a straightening segment (330), and a turning segment (332); and
a second flow channel (110) defined by a second airfoil (304) and the center airfoil (306);

characterized in that:

said turning segment comprises a turn radius (334) configured to facilitate separation of the flow of fluid in the first flow passage into a first stream (340) having relatively reduced particulates with respect to a second stream (338), wherein the first flow is capable of being directed to the sensor;
said second flow channel (110) is configured to generate a low pressure area (344) downstream of said sensor (106); said sensing assembly further comprising:
a converging V-channel segment (208) of a third flow channel (206), the third flow channel (206) defined between a first leg (202) and a parallel second leg (204) of an extension member (112) of the sensor assembly, wherein the first airfoil body (302), the second airfoil body (304) and the center airfoil body (306) extend orthogonally with respect to said extension member (112), V-channel segment (208) accelerating the flow of fluid.

2. A sensing assembly in accordance with claim 1, wherein said third flow channel (206) further comprises a straightening segment (210), said converging V-channel segment (208) upstream with respect to the straightening segment (210).

3. A sensing assembly in accordance with either of claim 1 or 2, wherein a cross-section of each leg (202,204) is symmetrical with respect to each other about a centerline of said third flow channel (206).

4. A sensing assembly (100) in accordance with any preceding Claim, wherein said sensor of said sensor

assembly (104) further comprises a sensing element (106) and a sheath (308) at least partially surrounding said sensing element.

5. A sensing assembly (100) in accordance with any of Claims 1 to 3, wherein said sensor of said sensor assembly (104) further comprises a sensing element (106) and a sheath (308) comprising an inlet opening (316) and an outlet opening (318) spaced circumferentially about said sheath. 5
6. A sensing assembly (100) in accordance with either of claim 1, wherein said first airfoil body (302) comprises a J-shaped cross-section. 10
7. A method of sensing a process parameter, said method comprising: 15
 - channeling a flow of fluid through a first flow passage (108) defined between a first airfoil body (302) and a center airfoil body (306); 20
 - channeling the flow of fluid through a second flow passage (110) defined between a second airfoil body (304) and the center airfoil body (306); 25
 - accelerating the flow of fluid through a converging V-channel segment (208) of a third flow channel (206), the third flow channel (206) defined between a first leg (202) and a parallel second leg (204) of an extension member (112) of a sensor assembly, wherein the first airfoil body (302), the second airfoil body (304) and the center airfoil body (306) extend orthogonally with respect to said extension member (112); 30
 - turning the flow of fluid in the first flow passage (108) to facilitate separating the flow of fluid in the first flow passage into a first stream (340) having relatively reduced particulates with respect to a second stream (338); and 35
 - directing the first stream (340) to a sensor element (106). 40
8. A method in accordance with Claim 7, further comprising generating an area of relatively high pressure in the first flow passage (108) and generating an area of relatively low pressure (344) in the second flow passage (110). 45
9. A method in accordance with either of Claim 7 or 8, further comprising reducing a velocity of the flow of fluid exiting the first flow passage (108) proximate the sensor element (106). 50
10. A method in accordance with either of Claim 7 or 8, further comprising reducing a velocity of the flow of fluid exiting the first flow passage (108) proximate the sensor element (106) using a sheath (308) surrounding the sensor element. 55

11. A method in accordance with either of Claim 7 or 8, further comprising directing the flow of fluid exiting the first flow passage (108) into an opening in a sheath (308) surrounding the sensor element (106).

Patentansprüche

1. Messanordnung (100), umfassend:

eine Basis (102);
 eine Sensoranordnung (104), wobei die Sensoranordnung einen Sensor (106) umfasst;
 einen ersten Strömungskanal (108), der von einer ersten Turbinenschaufel (302) und einer mittleren Turbinenschaufel (306) festgelegt ist; wobei der erste Strömungskanal einen konvergierenden Abschnitt (328), einen geraden Abschnitt (330) und einen abbiegenden Abschnitt (332) aufweist; und
 einen zweiten Strömungskanal (110), der von einer zweiten Turbinenschaufel (304) und der mittleren Turbinenschaufel (306) festgelegt ist;

dadurch gekennzeichnet, dass:

das abbiegende Segment einen Biegeradius (334) umfasst, der zum Erleichtern der Trennung des Fluidstroms im ersten Strömungsweg in einen ersten Strom (340) mit relativ reduzierten Feststoffen in Bezug auf einen zweiten Strom (338) konfiguriert ist, wobei der erste Strom zu dem Sensor geführt werden kann;
 der zweite Strömungskanal (110) zum Erzeugen eines dem Sensor (106) nachgeschalteten Niederdruckbereichs (344) konfiguriert ist;
 die Messanordnung weiterhin umfasst:

einen konvergierenden V-Kanalabschnitt (208) eines dritten Strömungskanals (206), wobei der dritte Strömungskanal (206) zwischen einem ersten Zweig (202) und einem parallelen zweiten Zweig (204) eines Verlängerungselements (112) der Sensorvorrichtung festgelegt ist, wobei sich der Körper der ersten Turbinenschaufel (302), der Körper der zweiten Turbinenschaufel (304) und der Körper der mittleren Turbinenschaufel (306) orthogonal in Bezug auf das Verlängerungselement (112) erstrecken, wobei der V-Kanalabschnitt (208) den Fluidstrom beschleunigt.

2. Messanordnung nach Anspruch 1, wobei der dritte Strömungskanal (206) weiterhin einen sich begradi- genden Abschnitt (210) umfasst, wobei der konvergierende V-Kanalabschnitt (208) in Bezug auf den sich begradi- genden Abschnitt (210) vorgeschaltet

angeordnet ist.

3. Messanordnung nach Anspruch 1 oder 2, wobei ein Querschnitt jedes Zweigs (202, 204) um eine Mittellinie des dritten Strömungskanals (206) symmetrisch zueinander ist. 5
4. Messanordnung (100) nach einem der vorhergehenden Ansprüche, wobei der Sensor der Sensoranordnung (104) weiterhin einen Messaufnehmer (106) und eine Ummantelung (308) umfasst, die den Messaufnehmer mindestens teilweise umgibt. 10
5. Messanordnung (100) nach einem der Ansprüche 1 bis 3, wobei der Sensor der Sensoranordnung (104) weiterhin einen Messaufnehmer (106) und eine Ummantelung (308) umfasst, die eine Eingangsöffnung (316) und einer Ausgangsöffnung (318) umfasst, die in Umfangsrichtung um die Ummantelung beanstanden sind. 15
6. Messanordnung (100) nach Anspruch 1, wobei der Körper der ersten Turbinenschaufel (302) einen J-förmigen Querschnitt umfasst. 20
7. Verfahren zum Ermitteln eines Verfahrensparameters, wobei das Verfahren umfasst: 25

Kanalisieren eines Fluidstroms durch einen ersten Strömungsweg (108), der zwischen dem Körper einer ersten Turbinenschaufel (302) und dem Körper einer mittleren Turbinenschaufel (306) festgelegt ist; 30

Kanalisieren des Fluidstroms durch einen zweiten Weg (110), der zwischen dem Körper einer zweiten Turbinenschaufel (304) und dem Körper der mittleren Turbinenschaufel (306) festgelegt ist; 35

Beschleunigen des Fluidstroms durch einen konvergierenden V-Kanalabschnitt (208) eines dritten Strömungskanals (206), wobei der dritte Strömungskanal (206) zwischen einem ersten Zweig (202) und einem parallelen zweiten Zweig (204) eines Verlängerungselements (112) einer Sensorvorrichtung festgelegt ist, wobei sich der Körper der ersten Turbinenschaufel (302), der Körper der zweiten Turbinenschaufel (304) und der Körper der mittleren Turbinenschaufel (306) orthogonal in Bezug auf das Verlängerungselement (112) erstrecken; 40

Ändern der Richtung des Fluidstroms in dem Strömungsweg (108) zum Erleichtern der Trennung des Fluidstroms im ersten Strömungsweg in einen ersten Strom (340) mit relativ reduzierten Feststoffen in Bezug auf einen zweiten Strom (338); und 45

Führen des ersten Stroms (340) zu einem Messaufnehmer (106). 50

8. Verfahren nach Anspruch 7, weiterhin umfassend das Erzeugen eines Bereichs relativ hohen Drucks in dem ersten Strömungsweg (108) und das Erzeugen eines Bereichs relativ niedrigen Drucks (344) in dem zweiten Strömungsweg (110). 5

9. Verfahren nach Anspruch 7 oder 8, weiterhin umfassend das Senken einer Geschwindigkeit des Fluidstroms, der aus dem ersten Strömungsweg (108) neben dem Messaufnehmer (106) austritt. 10

10. Verfahren nach Anspruch 7 oder 8, weiterhin umfassend das Senken einer Geschwindigkeit des Fluidstroms, der aus dem ersten Strömungsweg (108) neben dem Messaufnehmer (106) austritt, unter Verwendung einer Ummantelung (308), die den Messaufnehmer umgibt. 15

11. Verfahren nach Anspruch 7 oder 8, weiterhin umfassend das Führen des Fluidstroms, der aus dem ersten Strömungsweg (108) austritt, zu einer Öffnung in einer Ummantelung (308), die den Messaufnehmer (106) umgibt. 20

Revendications

1. Ensemble de détection (100) comprenant :

une base (102) ;
un ensemble de capteur (104), ledit ensemble de capteur comprenant :

un capteur (106) ;
un premier canal d'écoulement (108) défini par un premier profil aérodynamique (302) et un profil aérodynamique central (306) ;
le premier canal d'écoulement comprenant un segment convergent (328), un segment de redressement (330) et un segment tournant (332) ; et
un deuxième canal d'écoulement (110) défini par un second profil aérodynamique (304) et le profil aérodynamique central (306) ;

caractérisé en ce que :

ledit segment tournant comprend un rayon de rotation (334) configuré pour faciliter la séparation de l'écoulement de fluide dans le premier passage d'écoulement en un premier courant (340) ayant des particules relativement réduites par rapport à un second courant (338), dans lequel le premier courant est à même d'être acheminé vers le capteur ;
ledit deuxième canal d'écoulement (110) est configuré pour générer une zone de basse pres-

sion (344) en aval dudit capteur (106) ;

ledit ensemble de détection comprenant en outre :

- un segment de canal convergent en V (208) d'un troisième canal d'écoulement (206), le troisième canal d'écoulement (206) étant défini entre une première jambe (202) et une seconde jambe parallèle (204) d'un élément d'extension (112) de l'ensemble de capteur, dans lequel le premier corps de profil aérodynamique (302), le second corps de profil aérodynamique (304) et le corps de profil aérodynamique central (306) s'étendent orthogonalement par rapport audit élément d'extension (112), le segment de canal en V (208) accélérant l'écoulement de fluide. 5 10 15
2. Ensemble de détection selon la revendication 1, dans lequel ledit troisième canal d'écoulement (206) comprend en outre un segment de redressement (210), ledit segment de canal convergent en V (208) étant en amont par rapport au segment de redressement (210). 20
3. Ensemble de détection selon l'une ou l'autre des revendications 1 ou 2, dans lequel une section transversale de chaque jambe (202, 204) est symétrique par rapport à l'autre autour d'un axe dudit troisième canal d'écoulement (206). 25 30
4. Ensemble de détection (100) selon l'une quelconque des revendications précédentes, dans lequel ledit capteur dudit ensemble de capteur (104) comprend en outre un élément de détection (106) et une gaine (308) entourant au moins en partie ledit élément de détection. 35
5. Ensemble de détection (100) selon l'une quelconque des revendications 1 à 3, dans lequel ledit capteur dudit ensemble de capteur (104) comprend en outre un élément de détection (106) et une gaine (308) comprenant une ouverture d'entrée (316) et une ouverture de sortie (318) espacées sur la circonférence autour de ladite gaine. 40 45
6. Ensemble de détection (100) selon l'une quelconque de la revendication 1, dans lequel ledit premier corps de profil aérodynamique (302) comprend une section transversale en forme de J. 50
7. Procédé de détection d'un paramètre de processus, ledit procédé comprenant : 55

la canalisation d'un écoulement de fluide à travers un premier passage d'écoulement (108) défini entre un premier corps de profil aérodynamique (302) et un corps central de profil aérodynamique (306) ;

la canalisation de l'écoulement de fluide à travers un second passage d'écoulement (110) défini entre un second corps de profil aérodynamique (304) et le corps central de profil aérodynamique (306) ;

l'accélération de l'écoulement de fluide à travers un segment de canal convergent en V (208) d'un troisième canal d'écoulement (206), le troisième canal d'écoulement (206) étant défini entre une première jambe (202) et une seconde jambe parallèle (204) d'un élément d'extension (112) d'un ensemble de capteur, dans lequel le premier corps de profil aérodynamique (302), le second corps de profil aérodynamique (304) et le corps central de profil aérodynamique (306) s'étendent orthogonalement par rapport audit élément d'extension (112) ;

la rotation de l'écoulement de fluide dans le premier passage d'écoulement (108) pour séparer l'écoulement de fluide dans le premier passage d'écoulement en un premier courant (340) ayant des particules relativement réduites par rapport à un second courant (338) ; et

l'acheminement du premier courant (340) vers un élément de détection (106).

8. Procédé selon la revendication 7, comprenant en outre la génération d'une zone de pression relativement élevée dans le premier passage d'écoulement (108) et la génération d'une zone de pression relativement basse (344) dans le deuxième passage d'écoulement (110).
9. Procédé selon l'une quelconque des revendications 7 ou 8, comprenant en outre la réduction d'une vitesse de l'écoulement de fluide quittant le premier passage d'écoulement (108) à proximité de l'élément de détection (106).
10. Procédé selon l'une quelconque des revendications 7 ou 8, comprenant en outre la réduction d'une vitesse de l'écoulement de fluide quittant le premier passage d'écoulement (108) à proximité de l'élément de détection (106) en utilisant une gaine (308) entourant l'élément de détection.
11. Procédé selon l'une quelconque des revendications 7 ou 8, comprenant en outre l'acheminement de l'écoulement de fluide quittant le premier passage d'écoulement (108) dans une ouverture d'une gaine (308) entourant l'élément de détection (106).

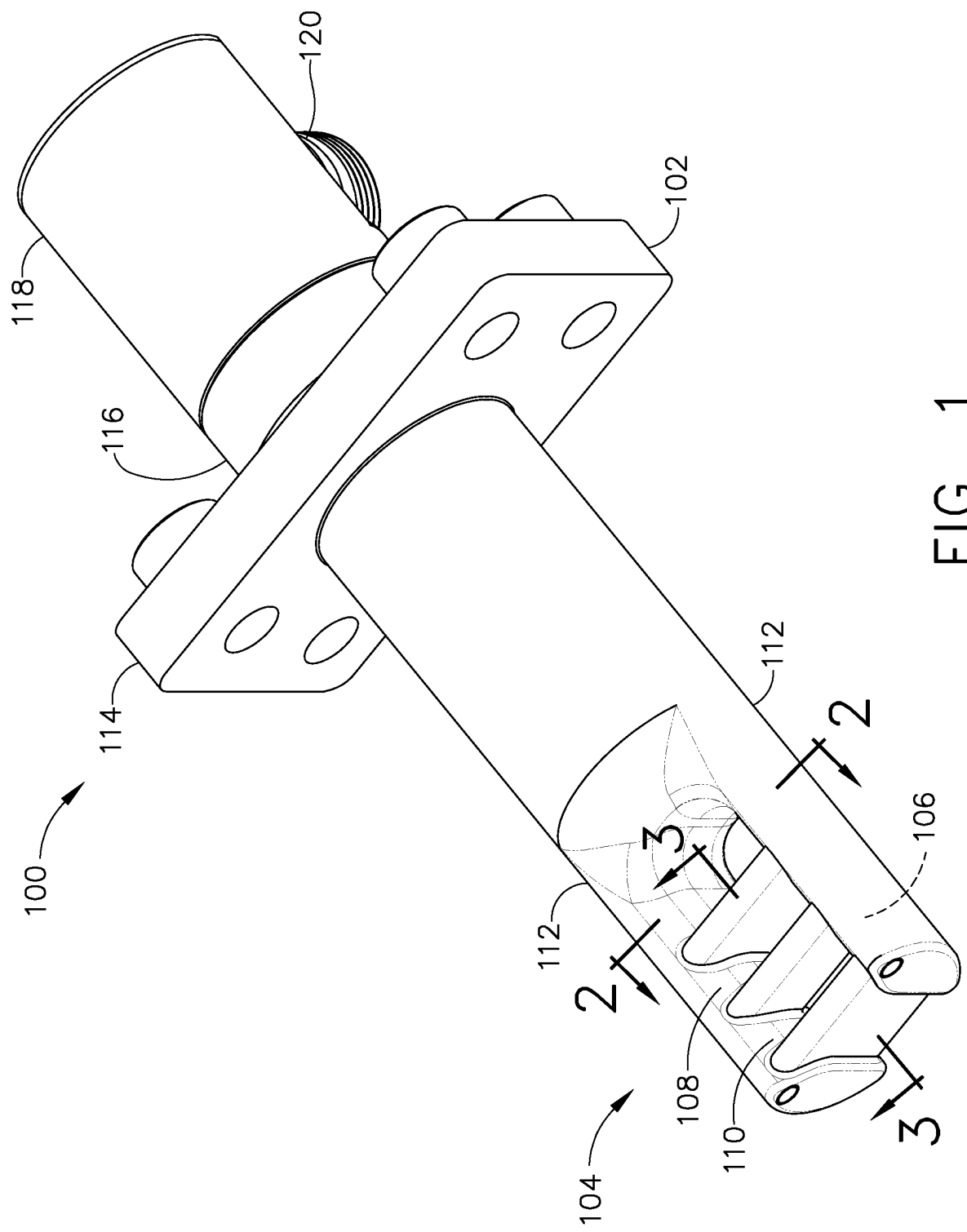


FIG. 1

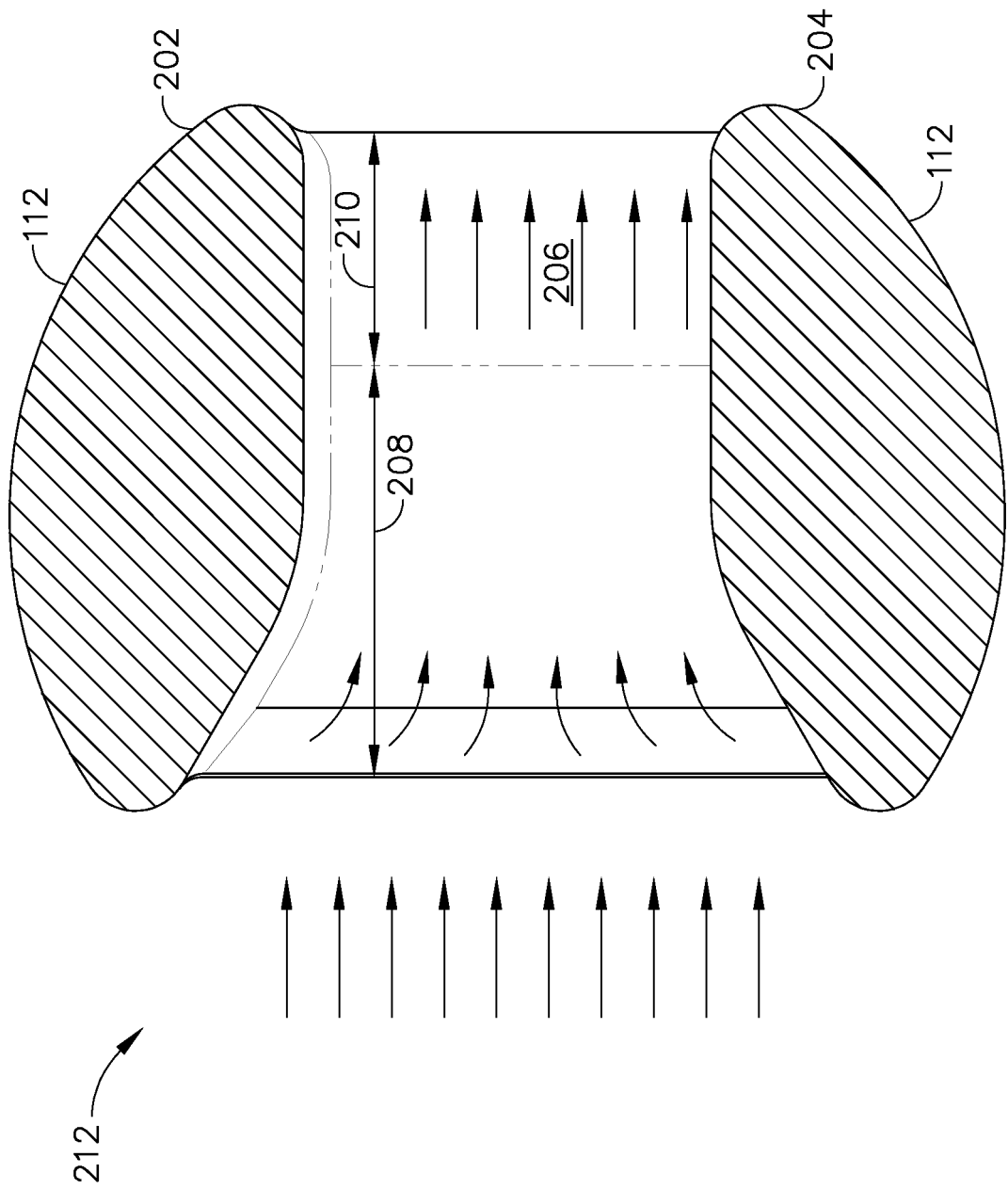


FIG. 2

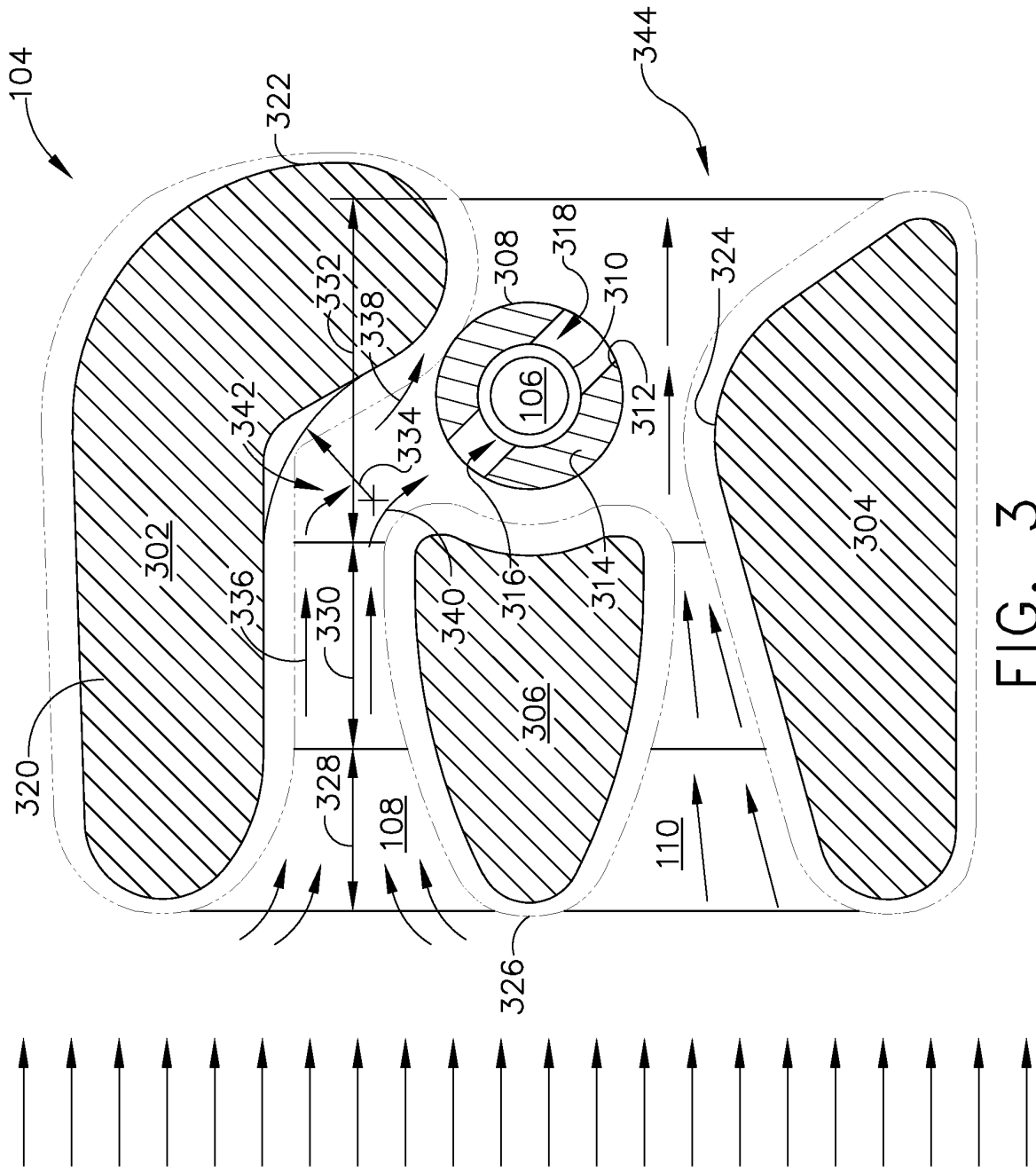


FIG. 3

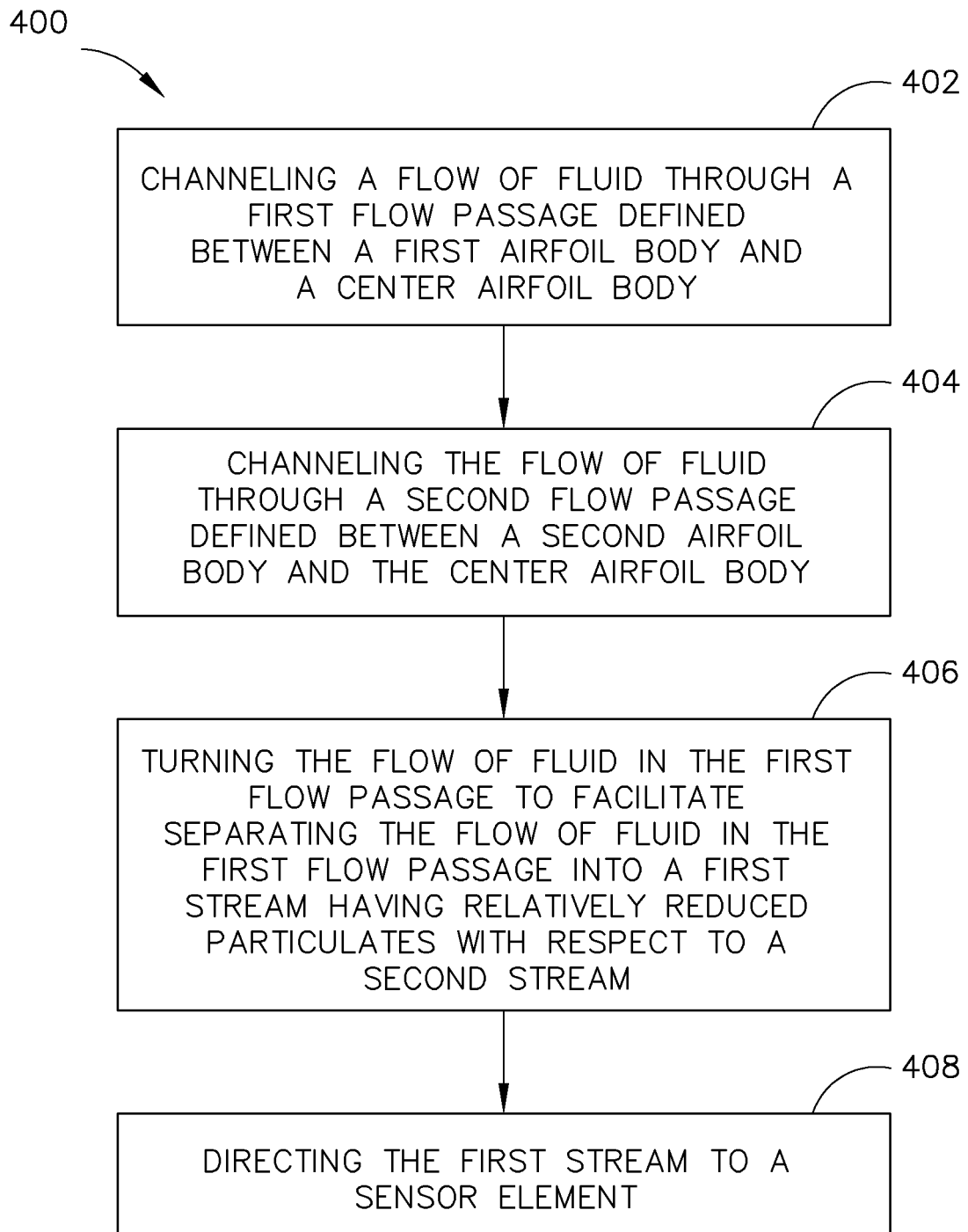


FIG. 4

REFERENCES CITED IN THE DESCRIPTION

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